(12) UK Patent Application (19) GB (11) 2 145 381 A

(43) Application published 27 Mar 1985

(21) Application No **8426403**

(22) Date of filing **1 Dec 1982**

Date lodged **18 Oct 1984**

(60) Derived from Application No **8234318** under Section 15(4) of the Patents Act 1977

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(51) INT CL[4]
B64C 27/26 F02K 3/02 // B64C 15/00

(52) Domestic classification
B7G JAE JAR JVF JVN
B7W HAA
F1J 1F2C2 1X 2A1A 2A1D
U1S 1840 B7G B7W F1J

(56) Documents cited
None

(58) Field of search
B7G
B7W
F1J

(54) **Powerplant for a helicopter**

(57) A power-plant for a compound helicopter which has wings 12 in addition to a helicopter rotor 14 comprises one or more gas turbine engines 16 each with a low pressure compressor 18, a gas generator 20, a power turbine 22 driven by the gas generator and connected through a gearbox 32 to drive the helicopter rotor, and a variable area final propulsion nozzle 24 which receives the exhaust from the power turbine. Augmentor wing flaps 28 are provided on the wings and the engines are provided with ducting for supplying air from the low pressure compressor to the augmentor run to provide additional lift and thrust from the wings. Operation is as described in application 2130984 A.

Fig. 1.

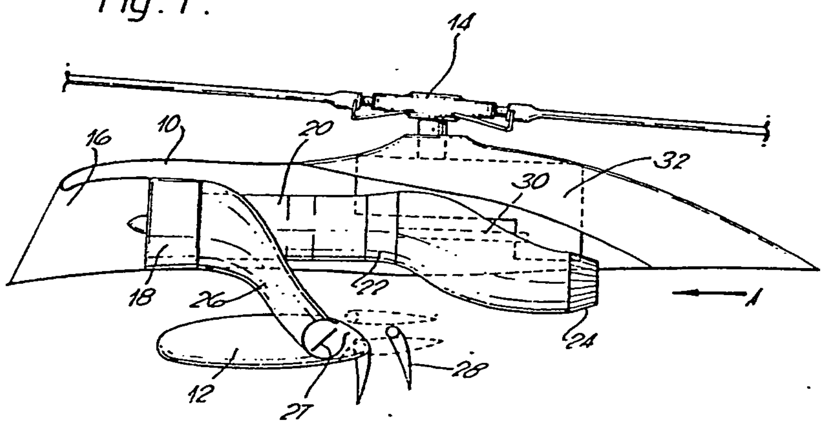

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Fig. 1.

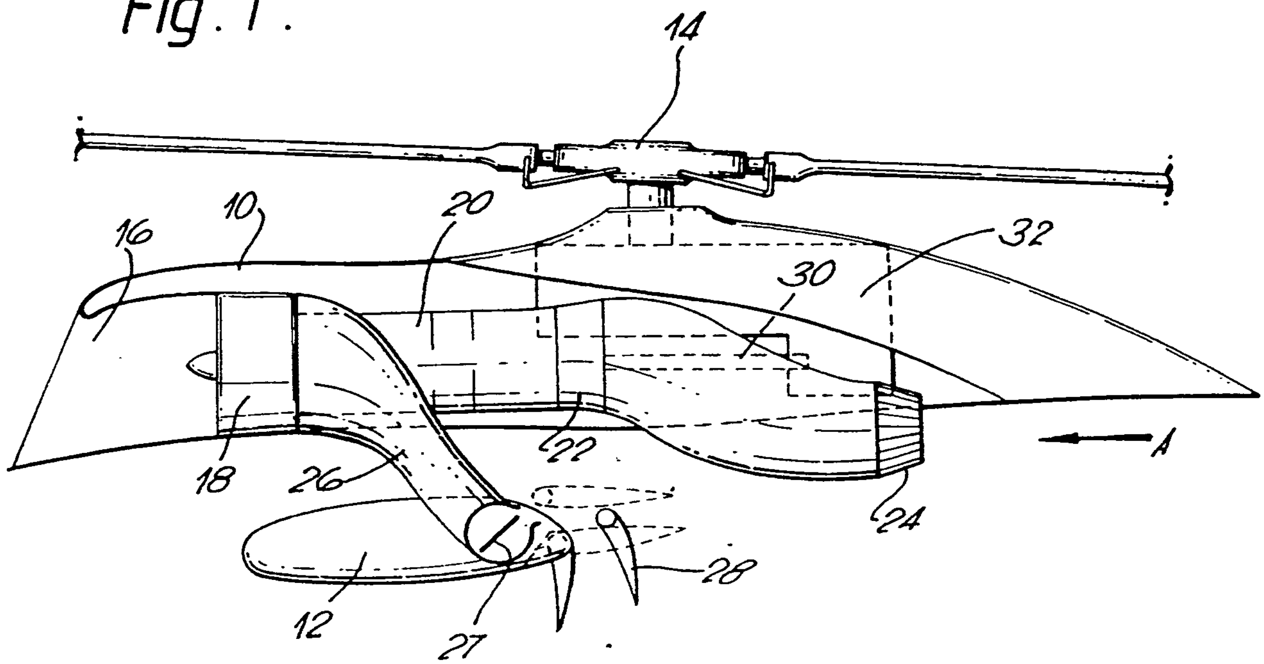
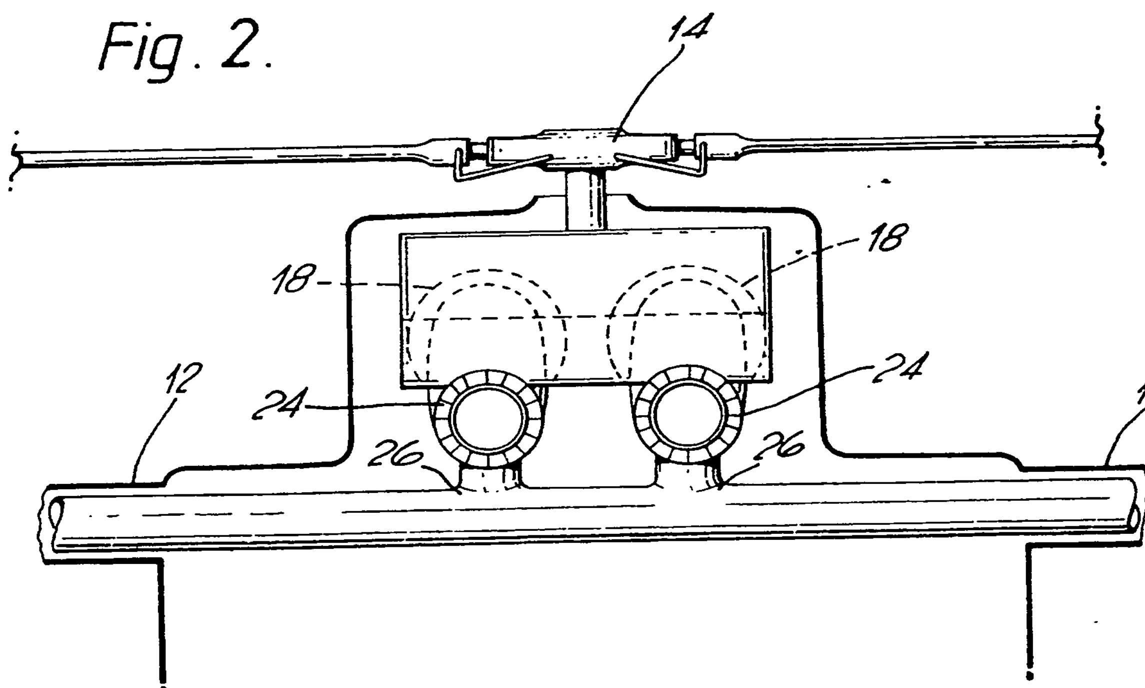


Fig. 2.



SPECIFICATION

Powerplant for a helicopter

The present invention relates to power-plants for compound helicopters. The term compound helicopter is used to denote a helicopter having wings in addition to the normal helicopter lifting rotor.

Compound helicopters are not new, and several different approaches have been used in their design. For example, it has been proposed to use one or more engines to provide power for driving the rotor and one or more separate engines for producing horizontal propulsion. This approach has the disadvantage that during the cruise mode of operation, the engine driving the rotor is throttled back or even shut down, and then becomes dead weight, and the cruise engines do not contribute to the lift at take-off.

An alternative approach, therefore, has been to make the same engine or engines perform the tasks of driving the rotor and providing forward propulsive thrust. This entails the problem of switching from one function to the other, and several different proposals have been made for doing this, none of which have yet found acceptance.

Examples of various compound helicopters and power-plants are disclosed in UK Patents Nos. 1,024,969, 1,108,454 and 1,120,658. These patent specifications disclose twin-engined helicopters and various methods by which the two engines are switched from driving the helicopter rotor or rotors to providing horizontal thrust. In all of these proposals the engines are either used to provide lift or forward thrust, and the disadvantage of this arrangement is that the engine is slow to change over from one mode of operation to the other.

An arrangement which does not suffer from this disadvantage is disclosed in U.K. Patent No. 980,608. In this arrangement a variable pitch fan is provided, and both the fan and the helicopter rotor are driven at all times through gearing from the engine low pressure turbine. The amount of power going to the helicopter rotor is varied by changing the pitch of the blades to increase or decrease the power required for driving the fan. However, in this arrangement, as in other arrangements referred to above, the engine is specifically designed for use as a compound helicopter power-plant. Also the variable pitch fan is of relatively large diameter and this puts a limitation on the type of aircraft installation in which it can be used.

It is an object of the present invention to provide a power-plant for a compound helicopter which consists of one or more gas turbine engines the, or each, of which is adapted to provide both the power for vertical lift and horizontal thrust for forward propulsion.

According to the present invention there is provided a power plant for a compound helicopter which has a main lift rotor and at least one wing provided with one or more lift augmentation devices for producing lift in addition to that normally produced by the wing in forward flight, the power-plant comprising one or more gas turbine engines which have a low pressure compressor, a core gas generator which drives the compressor, a power turbine driven by the exhaust of the core gas generator and connected to drive an output shaft for connection to the helicopter rotor, ducting for conveying at least part of the air compressed by the low pressure compressor to the or each, wing, and a variable area propulsion nozzle downstream of the power turbine, said nozzle receiving the exhaust from the power turbine and being operable to vary the power absorbed by the power turbine and simultaneously vary the propulsive thrust produced by the nozzle.

By this means the variable area nozzle can be used to control both the power generated by the power turbine for producing lift from the helicopter rotor, and the propulsive thrust generated by the engine for forward propulsion. The variable area final nozzle is a relatively simple modification to make to a standard engine for providing the variation in power between lift and forward propulsion, (in addition, that is, to the drive shaft and gearbox for driving the helicopter rotor which is essential in all helicopter power-plants). This proposal also avoids the problems of the above-mentioned prior proposals in that the helicopter rotor is driven at all times, while the power split between lift and forward propulsion from the powerplant is variable over a wide range of values.

An example of the invention will now be more particularly described with reference to the accompanying drawing in which:

Figure 1 shows the top part of a twin-engined compound helicopter with its helicopter rotor, augmentor wing, and a power-plant, constructed in accordance with the present invention, and,

Figure 2 is a view of arrow A of Figure 1.

Referring now to the drawings, there is shown a compound helicopter 10 having wings 12, one on each side, and a helicopter rotor 14. A power-plant comprising two gas turbine engines 16 is provided. Each engine has a low pressure compressor 18, a core gas generator 20 which drives the low pressure compressor, a power turbine 22 which is driven from the exhaust of the core gas generator 20, and a variable area propulsive nozzle 24. Each engine 16 incorporates ducting 26 suitable for conducting compressed air to the wings 12 of the helicopter.

The arrangement of the parts of the power-plant is as follows:-

At least a part of the air flow compressed by each core engine is passed to the wings 12 via ducting 26, and the wings have augmentor flaps 28 at the trailing edges thereof. The augmentor wing is known per se and its operationis not described here in detail. It is sufficient to say that the air from the ducting 26 passes to atmosphere through the flaps 28 and induces air flowing over the aircraft wing to pass between the flaps and to stick to the top flap to increase the wing lift. The flaps 28 are also pivotable between the position shown in full lines, which provides additional upwardly directed thrust to add to the lift generated by the rotor 14, and the position shown in dotted lines which provides forward thrust. The compressed air from the two engines is supplied to opposite sides of a diaphragm 27 which divides the ducting 26 longitudinally. This both engines

supply air to the flaps 28 along the whole length of the wind and, failure of one engine will not affect the flow from the other one. The core gas generator 20 produces power to drive the compressor 18, and the exhaust from the gas generator passes through the power turbine 22. A shaft 30 and gearbox 32 interconnect both of the power turbines 22 with the helicopter rotor 14 to drive the rotor. The exhaust from each of the power turbines passes to atmosphere through the variable area final nozzle, which, in this example, is shown pointing rearwards all of the time, but which could, if desired, be vectorable to direct the exhaust gases downwardly, for increasing lift, or sideways for attitude control.

The operation of the compound helicopter is as follows:

For take-off each of the gas turbine engines is run at maximum power with the variable area final nozzle in its maximum area position. This provides the greatest pressure drop across the power turbine and hence maximum drive to the rotor 14 which generates most of the lift, and minimum propulsive thrust from the final nozzle. Additional lift is generated by the compressed air from the low pressure compressor passing through the augmentor flaps 28 which are pivoted to direct the air downwardly. Thus the helicopter can take off vertically, with only a very minor part of the energy remaining in the exhaust gases creating virtually no forward thrust from the variable area final nozzles 24. Clearly, if the variable area final nozzles 24 are made to be vectorable to direct the exhaust gases downwardly, any energy remaining could be directed to provide still further lift.

Once airborne, if a conventional tilting helicopter rotor is used, forward flight can be initiated in the normal way. Alternatively the area of the final nozzles can be adjusted to produce some forward thrust which will provide some forward velocity so that gradually the wings will start to produce lift due to the forward motion of the helicopter. This process can be hastened by gradually pivoting the augmentor flaps 28 towards the horizontal position which provides a gradually increasing forward thrust. When the wings have started to contribute to the lifting force necessary to keep the helicopter in the air, the variable area final nozzles 24 are closed down to a minimum exit area to off-load the power turbine 22 thus reducing the power to the helicopter rotor 14 and increasing still further the forward thrust on the helicopter.

The reduction of power to, and consequent slowing down of, the helicopter rotor is such as to enable relatively high forward speeds, (of the order of 250 mph) to be achieved without the rotor tip mach number of the advancing rotating blades become excessive.

The advantages of the augmentor wing as part of the combination are that it has a high lift coefficient and produces low drag at medium speed. It also allows the wing plan area to be minimised which reduces the effect of the rotor downwash on the wing lift.

A further advantage of a compound helicopter as described above is that by simply choosing an appropriate nozzle area, enough forward thrust can be produced without a significant loss of lift from the rotor, to enable the helicopter to perform a short take-off if overloaded, by running forward on the ground until the wing lift is sufficient to provide lift-off. This can significantly increase the range of the helicopter by increasing the amount of fuel carried at take-off.

CLAIMS

1. A power-plant for a compound helicopter which has a main lift rotor and at least one wing provided with one or more lift augmentation devices for producing lift in addition to that normally produced by the wing in forward flight, the power plant comprising one or more gas turbine engines which have a low pressure compressor, a core gas generator which drives the compressor, a power turbine driven by the exhaust of the core gas generator and connected to drive an output shaft for connection to the helicopter rotor, ducting for conveying at least part of the air compressed by the low pressure compressor to the, or each, wing, and a variable area propulsion nozzle downstream of the power turbine, said nozzle receiving the exhaust from the power turbine and being operable to vary the power absorbed to the power turbine and simultaneously vary the propulsive thrust produced by the nozzle.

2. A power-plant as claimed in Claim 1 wherein the variable area nozzle of the, or each, engine is vectorable to provide either lift thrust or forward propulsive thrust.

3. A power-plant as claimed in any one of the preceding claims wherein two gas turbine engines are provided and the power turbines of each engine are coupled through a gearbox to drive a common output shaft.

4. A power-plant as claimed in Claim 3 wherein the ducting is divided longitudinally by a diaphragm and the air compressed by one engine is directed to one side of the diaphragm and the air compressed by the other engine is supplied to the other side of the diaphragm, the diaphragm and ducting being constructed and arranged so that failure of one of the engines does not affect the supply of compressed air by the other engine to the or each wing.

5. A power-plant substantially as hereinbefore more particularly described with reference to the accompanying drawings.

Printed in the UK for HMSO, D8818935, 1/85, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.